

## CLAIMS

### What is claimed is:

1. A vertical cavity surface emitting laser (VCSEL) capable of polarization switching, comprising:
  - a substrate;
  - a bottom mirror disposed on the substrate;
  - an active region disposed on the bottom mirror, the active region including a current aperture and a VCSEL cavity, wherein an active region size is smaller than a bottom mirror size;
  - a first pair of bottom electrodes disposed on the bottom mirror near a bottom periphery of the active region; and
  - a first pair of top electrodes disposed on the active region near a top periphery of the active region.
2. The VCSEL of claim 1, wherein the bottom mirror is a semiconductor distributed Bragg reflector mirror.
3. The VCSEL of claim 1, wherein the active region size is between approximately 3 and 20 microns in diameter.
4. The VCSEL of claim 1, wherein:
  - the first pair of bottom electrodes are disposed approximately 90 Degrees from one another around the bottom periphery;
  - the first pair of top electrodes are disposed approximately 90 Degrees from one another around the top periphery;
  - one of the first pair of bottom electrodes is disposed approximately 180 Degrees from one of the first pair of top electrodes; and

another of the first pair of bottom electrodes is disposed approximately 180 Degrees from another of the first pair of top electrodes.

5. The VCSEL of claim 4, further comprising a driver circuit, the driver circuit including:  
means for supplying one or more first supply energies to the one of the first pair of bottom electrodes that is disposed approximately 180 Degrees from the one of the first pair of top electrodes;  
means for supplying one or more second supply energies to the another of the first pair of bottom electrodes that is disposed approximately 180 Degrees from the another of the first pair of top electrodes;  
means for controlling the one or more first and second supply energies; and  
means for switching the between the one or more first and second supply energies.
6. The VCSEL of claim 1, further comprising  
a top mirror disposed on the active region.
7. The VCSEL of claim 6, wherein the top mirror is a dielectric distributed Bragg reflector having a top mirror thickness of less than 3 micron.
8. The VCSEL of claim 7, wherein the top mirror thickness is 1 micron or less.
9. The VCSEL of claim 1, further comprising:  
a second pair of bottom electrodes disposed on the bottom mirror near the bottom periphery of the active region; and  
a second pair of top electrodes disposed on the active region near the top periphery of the active region.
10. The VCSEL of claim 9, wherein:  
the first and second pairs of bottom electrodes are all disposed approximately 90 Degrees from one another around the bottom periphery;

the first and second pairs of top electrodes are all disposed approximately 90 Degrees from one another around the top periphery; one of the first and second pairs of bottom electrodes is disposed approximately 180 Degrees from one of the first and second pairs of top electrodes, respectively; and another of the first and second pairs of bottom electrodes is disposed approximately 180 Degrees from another of the first and second pairs of top electrodes, respectively.

11. The VCSEL of claim 10, further comprising a driver circuit, the driver circuit including:  
means for supplying one or more first supply energies to the one of the first and second pairs of bottom electrodes that is disposed approximately 180 Degrees from the one of the first and second pairs of top electrodes;  
means for supplying one or more second supply energies to the another of the first and second pairs of bottom electrodes that is disposed approximately 180 Degrees from the another of the first and second pairs of top electrodes;  
means for controlling the one or more first and second supply energies; and  
means for switching between the one or more first and second supply energies.
12. A multi-cavity vertical cavity surface emitting laser (VCSEL) capable of simultaneous multiple polarization emissions, comprising:  
a substrate;  
a bottom mirrors disposed on the substrate;  
a plurality of active regions disposed on the bottom mirror, each active region including a current aperture and a VCSEL cavity, wherein a combined active region size of the plurality of active regions is smaller than a bottom mirror size;  
a plurality of bottom electrodes disposed on the bottom mirror, each bottom electrode being positioned near a bottom periphery of a different one of the plurality of active regions; and  
a plurality of top electrodes disposed on the active region, each top electrode being positioned near a top periphery of the different one of the plurality of active region, wherein:

each bottom electrode and each top electrode are positioned approximately 180 Degrees from one another around the different one of the plurality of active regions.

13. The multi-cavity VCSEL of claim 12, further comprising a driver circuit, the driver circuit including:

means for supplying a plurality of supply energies to each bottom electrode and each top electrode that are positioned approximately 180 Degrees from one another around the different one of the plurality of active regions;  
means for controlling the plurality of supply energies; and  
means for switching the between the plurality of supply energies.

14. A method of operating a vertical cavity surface emitting laser (VCSEL) for polarization switching comprising the steps of:

providing a VCSEL, the VCSEL including:

a substrate;  
a bottom mirror disposed on the substrate;  
an active region disposed on the bottom mirror, the active region including a current aperture and a VCSEL cavity, wherein an active region size is smaller than a bottom mirror size;  
a first pair of bottom electrodes disposed on the bottom mirror near a bottom periphery of the active region; and  
a first pair of top electrodes disposed on the active region near a top periphery of the active region;

switching one or more supply energies between a first electrically opposed pair of the top and bottom electrodes and a second electrically opposed pair of the top and bottom electrodes.

15. The method of claim 14, wherein the bottom mirror is a semiconductor distributed Bragg reflector mirror.

16. The method of claim 14, wherein the active region size is between approximately 3 and 20 microns in diameter.
17. The method of claim 14, wherein:  
the first pair of bottom electrodes are disposed approximately 90 Degrees from one another around the bottom periphery;  
the first pair of top electrodes are disposed approximately 90 Degrees from one another around the top periphery;  
one of the first pair of bottom electrodes is disposed approximately 180 Degrees from one of the first pair of top electrodes; and  
another of the first pair of bottom electrodes is disposed approximately 180 Degrees from another of the first pair of top electrodes.
18. The method of claim 17, wherein the step of switching includes providing a driver circuit, the driver circuit including:  
means for supplying one or more first supply energies to the one of the first pair of bottom electrodes that is disposed approximately 180 Degrees from the one of the first pair of top electrodes;  
means for supplying one or more second supply energies to the another of the first pair of bottom electrodes that is disposed approximately 180 Degrees from the another of the first pair of top electrodes;  
means for controlling the one or more first and second supply energies; and  
means for switching the between the one or more first and second supply energies.
19. The method of claim 14, wherein the VCSEL further includes a top mirror disposed on the active region.
20. The method of claim 19, wherein the top mirror is a dielectric distributed Bragg reflector having a top mirror thickness of less than 3 micron.
21. The method of claim 20, wherein the top mirror thickness is 1 micron or less.

22. The method of claim 14, wherein,  
the VCSEL further includes:  
a second pair of bottom electrodes disposed on the bottom mirror near the bottom  
periphery of the active region; and  
a second pair of top electrodes disposed on the active region near the top  
periphery of the active region; and  
the step of switching further includes:  
switching another one or more supply energies between a first electrically  
opposed pair of the second pair of top and bottom electrodes and second  
electrically opposed pair of the second pair of top and bottom electrodes.

23. The method of claim 22, wherein:  
the first and second pairs of bottom electrodes are disposed approximately 90 Degrees  
from one another around the bottom periphery;  
the first and second pairs of top electrodes are disposed approximately 90 Degrees from  
one another around the top periphery;  
one of the first and second pairs of bottom electrodes is disposed approximately 180  
Degrees from one of the first and second pairs of top electrodes, respectively; and  
another of the first and second pairs of bottom electrodes is disposed approximately 180  
Degrees from another of the first and second pairs of top electrodes, respectively.

24. The method of claim 23, wherein the step of switching includes providing a driver circuit,  
the driver circuit including:  
means for supplying one or more first supply energies to the one of the first and second  
pairs of bottom electrodes that is disposed approximately 180 Degrees from the one  
of the first and second pairs of top electrodes;  
means for supplying one or more second supply energies to the another of the first and  
second pairs of bottom electrodes that is disposed approximately 180 Degrees from  
the another of the first and second pairs of top electrodes;  
means for controlling the one or more first and second supply energies; and  
means for switching the between the one or more first and second supply energies.

25. A method of operating a vertical cavity surface emitting laser (VCSEL) for simultaneous multiple polarization switching comprising the steps of:

providing a VCSEL, the VCSEL including:

a substrate;

a bottom mirrors disposed on the substrate;

a plurality of active regions disposed on the bottom mirror, each active region including a current aperture and a VCSEL cavity, wherein a combined active region size of the plurality of active regions is smaller than a bottom mirror size;

a plurality of bottom electrodes disposed on the bottom mirror, each bottom electrode being positioned near a bottom periphery of a different one of the plurality of active regions; and

a plurality of top electrodes disposed on the active region, each top electrode being positioned near a top periphery of the different one of the plurality of active region,

wherein each bottom electrode and each top electrode are positioned approximately 180 Degrees from one another around the different one of the plurality of active regions; and

switching one or more supply energies between a first electrically opposed pair of the plurality of top and bottom electrodes and all other electrically opposed pairs of the plurality of top and bottom electrodes.

26. The multi-cavity VCSEL of claim 25, further comprising a driver circuit, the driver circuit including:

means for supplying a plurality of supply energies to each bottom electrode and each top electrode that are positioned approximately 180 Degrees from one another around the different one of the plurality of active regions;

means for controlling the plurality of supply energies; and

means for switching the between the plurality of supply energies.

27. A vertical cavity surface emitting laser (VCSEL) driver circuit capable of polarization switching a VCSEL, the VCSEL including a plurality of pairs of polarizing electrical contacts, comprising:

means for supplying one or more supply energies to the plurality of pairs of polarizing electrical contacts of the VCSEL;  
means for controlling the one or more supply energies; and  
means for switching the one or more supply energies between the plurality of pairs of polarizing electrical contacts of the VCSEL.